

## Knowledge Work, Craft Work, and Calling

*Robert D. Austin and Lee Devin*

*If I were to put you in front of a dock and I pulled up a skid in front of you with fifty hundred-pound sacks of potatoes and there are fifty more skids just like it, and this is what you're gonna do all day, what would you think about — potatoes?*<sup>1</sup>

*I been sewin' the same stitch for the last nineteen years. Last week they put me on a new one. I think I'm gonna like this one a lot better.*<sup>2</sup>

*The worker . . . bore evidence of [diseases] . . . the joints in his fingers might be eaten by the acid . . . you could scarcely find a person who had the use of his thumb . . . the base of it had been slashed, till it was a mere lump of flesh against which the man pressed the knife to hold it . . . their knuckles were so swollen that their fingers spread out like a fan . . . pluckers had to pull off [acid-painted] wool with their bare hands till the acid had eaten their fingers off. . . .*<sup>3</sup>

1. Comments by a manual laborer in an interview recorded in Studs Terkel, *Working* (New York: Pantheon Books, 1972), p. xxxiv.

2. Comments of a textile worker recorded by Professor Jan Hammond, Harvard Business School, while writing a case on a garment factory in the American South. Personal communication with Jan Hammond.

3. Description of an early twentieth-century meat-packing plant, in ch. 9 of Upton

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Some parts of this chapter are adapted, by permission of Pearson Education Inc., from ch. 5 of Rob Austin and Lee Devin, *Artful Making: What Managers Need to Know About How Artists Work* (Upper Saddle River, NJ: Financial Times Prentice Hall, 2003).

For the Greeks, the grim realities of physical work, its bodily nature and transitory effects, compared unfavorably with the life of the mind, which brought humans closer to the gods.<sup>4</sup> According to Plato, the body “enslaved” humans; its need for sustenance demanded work that made people “too busy to practice philosophy” and prevented them from “seeing truth.”<sup>5</sup> Medieval Christians continued in these beliefs. Aquinas argued “that the active life impedes the contemplative, because it is impossible for anyone to be involved in external works and at the same time give himself to divine contemplation.”<sup>6</sup> This view underlay the monastic tradition, which required the devout to separate themselves from earthly concerns and to engage in contemplation that earned credit toward salvation.<sup>7</sup> Physical labor, the province of animals and varlets, made life in the monastery possible, but labor and work held different places in God’s plan. More favorable interpretations portrayed work as a means of purification,<sup>8</sup> a way to avoid the idleness that leads to unholy desires,<sup>9</sup> or, at best, a “secondary piety” with a distinctly lower place in any divine hierarchy.<sup>10</sup>

Renaissance thinkers broke with this tradition. Enthusiasm for creative work prompted an interpretation of the divine that centered less on

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Sinclair, *The Jungle* (New York: New American Library, 1906). According to an oft-repeated story, reading this book over breakfast prompted President Theodore Roosevelt to rush to the White House window and vomit. There is an on-line searchable version of the book at [http://www.online-literature.com/upton\\_sinclair/jungle/](http://www.online-literature.com/upton_sinclair/jungle/).

4. For a cogent summary of these beliefs and how they evolved over time, see Lee Hardy, *The Fabric of the World: Inquiries into Calling, Career Choice, and the Design of Human Work* (Grand Rapids: Eerdmans, 1990), pp. 6-16. Hardy quotes Hannah Arendt, who notes that, for the Greeks, a “capacity for immortal deed,” an “ability to leave imperishable traces behind” marks the best of people as truly human, separated from animals (Arendt, *The Human Condition* [Chicago: University of Chicago Press, 1958], p. 19).

5. Plato, *Phaedo*, trans. David Gallop (Oxford: Clarendon Press, 1975), 66b-d.

6. Aquinas, *Summa Theologica*, II, 2nd, Q. 182, quoted in Hardy, *The Fabric*, p. 18. Hardy also quotes the sixth-century pope Gregory the Great: “The contemplative life is greater in merit than the active, which labors in the exercise of present work, while the other already tastes with inward savor the rest that is to come.”

7. C. H. Lawrence, *Medieval Monasticism* (London: Longman, 1984).

8. Adriano Tilgher, *Work: What It Has Meant to Men Through the Ages* (New York: Arno Press, 1977), p. 41, quoted in Hardy, *The Fabric*, p. 23.

9. *The Rule of St. Benedict*, trans. Anthony C. Meisel and M. L. del Mastro (Garden City, NY: Doubleday, 1975), p. 10.

10. Eusebius of Caesarea, *Demonstratio Evangelica*, trans. W. J. Ferrar (London: SPCK, 1920), bk. I, chap. 8.

God removed from human activity and more on God's active role as Creator of the universe. Humans, made in God's image, also have creative powers: they are not bound, as are animals, to rote instinctive behaviors; they can learn and by learning can improve their processes and outcomes. The individual craftsman who lovingly shaped materials into a unique object for a particular purpose approached divinity by "imitat[ing] God the artisan of nature."<sup>11</sup>

Martin Luther moved the theology of work further in this direction. According to Luther, the duties that attach to our earthly *stations* are "fruits of the Spirit." *Vocation* is the call to love one's neighbor that comes to each person through execution of these duties.<sup>12</sup> In this sense of vocation, or *calling*, work gains religious significance. The activities of work are holy because they are assigned by God, part of God's grand design, nothing less than a way of carrying the cross, sharing in Christ's suffering. Calvin also argued for a divine interpretation of work:

[W]e know that men were created for the express purpose of being employed in labour of various kinds, and that no sacrifice is more pleasing to God than when every man applies diligently to his own calling, and endeavors to live in such a manner as to contribute to the general advantage.<sup>13</sup>

In this expansive conception, so long as the work is not aimed at base consumption or vain accumulation, the divine can be found in almost anything a person might do.

Although the Christian idea of vocation persists today, it has retreated under the challenge of the Industrial Revolution. As principles of mass production and scientific management took hold, they made a mockery of Luther's stations and divinely ordained duties. The most perfunctory look at eighteenth- and nineteenth-century mines, mills, and factories reveals stations designed, not by God for the general advantage, but by humans for worldly enrichment. Workers had less and less control over

11. Marsilio Ficino, *Platonica Theologica*, XIII, 3 vols., ed. Raymond Marcel (Paris: n.p., 1964-1970), p. 3, cited in Hardy, *The Fabric*, p. 28.

12. Hardy, *The Fabric*, pp. 46-47. Luther quotation is from *Luther's Works*, vol. 26 (St. Louis: Concordia, 1958), p. 217.

13. John Calvin, *A Commentary on the Harmony of the Evangelists*, vol. 2, trans. William Pringle (Grand Rapids: Eerdmans, 1949), p. 143, quoted in Hardy, *The Fabric*, p. 56.

their work, which they undertook in unsafe and dehumanizing conditions. It was difficult to square these experiences with the idea of work as vocation. This kind of work, critics suggested, drew people back toward animal-like rote repetition and deprived them of any sense of likeness with God.<sup>14</sup>

As mass production displaced craft, theological philosophy gave way to economic practicality. Focus on efficiency and economies of scale moved attention from the “meaning” of work to its worldly “purpose”: to create economic value. The technologies and practices that evolved throughout the eighteenth, nineteenth, and twentieth centuries reshaped the contours of costs that lay beneath work. Given these new contours, managers reshaped work to maximize business value. Workers became mere cogs in the resulting systems, leading many to regret “the lost sense of work as divine calling.”<sup>15</sup>

But history never stands still, and arrangements of work continue to change. The work of a website designer or biotech researcher in the twenty-first century differs extravagantly from that of a factory or slaughterhouse worker one hundred — or even twenty — years ago. Technological transformations now underway create the potential for new work structures. Our aim in this chapter is to show that there is reason to think that a good deal of future work will have a worker-centered structure resembling that of preindustrial craft. If so, “knowledge workers” of the future will be less oppressed than factory workers have been, and work may, for many, reclaim its status as a form of God-like creativity.<sup>16</sup> We base this hopeful view on simple pragmatism: in an economy based on knowledge and innovation, exploitation will not create value.

14. The secular version of this argument is mounted most famously by Karl Marx. See, e.g., “Alienated Labor,” in *Karl Marx: The Essential Writings*, ed. Frederic L. Bender (Boulder, CO: Westview Press, 1972).

15. Emil Brunner, *Christianity and Civilization*, part 2 (New York: Scribner’s Sons, 1949), p. 69.

16. It is possible, of course, to identify benefits to workers that resulted from the Industrial Revolution. Many workers, for example, improved their overall wealth and standard of living as their jobs industrialized. Some critics disagree (strenuously) that working conditions have, on the whole, been degraded by the changes that followed the Industrial Revolution. Others who acknowledge degradation in some cases may not agree that it is a direct and necessary consequence of industrialization. In this chapter we will not debate the adequacy of the various critiques of industrial working conditions. Our subject is the changes currently underway and their likely effects.



In the space available here, we will not be able adequately to address important questions raised by our argument. Most notable among these are: Will all people be able to do this new kind of work? What will become of those who cannot? In the medieval world a learned class assumed a privileged position; the world of knowledge work could produce a similarly exalted caste. We also will not fully address questions about the fundamental fairness of a world shaped by these new processes. We merely observe that evolving structures that give workers greater control in creating value also give them greater opportunities to be wholly involved in their jobs and thus to create and capture value for themselves. This *seems* more in keeping with an idea of work as vocation. But questions about fairness will remain.

Work that transforms knowledge into economic value promises to be vocationally rich. This promise contains potential for movement toward productive relationships among work, workers, and God. But nothing about it prevents work that both Protestant Reformers and medieval theologians would have considered a vain, even sinful, accumulation of personal wealth, for example. Future work will return important choices to workers, and it will locate responsibility for right living solidly within each individual.

At the heart of our argument about the shifting character of work, we analyze the determinants that shape work processes. This somewhat technical analysis has implications for the realization of the Christian idea of vocation, and, more broadly, for a theological view of work.

## **Preindustrial Making**

Try to envision the preindustrial world. Imagine having no idea of interchangeable parts, of economies of scale, of the possibilities of electrically powered machinery, of optimally efficient work processes. In order to help you cast your thoughts back to such a time, we have invented a description of medieval manufacturing that conforms to that world's facts of life as scholars have discovered them.<sup>17</sup> We use this narrative to develop

17. Examination of the history of daily life in ancient times is a recent development in scholarship. For obvious reasons (common workers did not write about themselves, and no one else wrote about them either), it is difficult to find out about ordinary people. We have

our description of work in preindustrial, industrial, and postindustrial settings.

### *An Armory on the River Severn*

Hugh of Llaneth, operator of the armory in the village of Upton on the River Severn, has worked ever since he can remember. He believes that to be human is to work, that in work lies his best chance for salvation and a return to God's grace. His parents sold him at age nine to Garth the miller. He showed promise as a fabricator in wood and metal, especially at carving the oaken gears through which the water wheel drives the millstones. These gears wear out quickly, so a good carver is always in demand.

After the miracle of his escape from drowning in the millrace, Garth gave his mill to the monks and passed Hugh on to the childless Philip the armorer. Hugh worked for Philip, as an apprentice, as a journeyman, and

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relied on the following in constructing our tale: Patricia Basing, *Trades and Crafts in Medieval Manuscripts* (New York: New Amsterdam Books, 1990); Morris Bishop, *The Middle Ages* (Boston: Houghton Mifflin, 1987); Jane Watkins, ed., *Studies in European Arms and Armor* (Philadelphia: Philadelphia Museum of Art, 1992), contributions by Claude Blair, Lionello G. Boccia, Evertt Fahy, Helmut Nickel, A. V. B. Norman, Stuart W. Pyhrr, and Donald J. La Rocca (in the C. Otto von Kienbusch Collection of the Philadelphia Museum of Art); John Cherry, *Medieval Craftsmen: Goldsmiths* (Toronto: University of Toronto Press, 1992); Marshall Claggett, *The Science of Mechanics in the Middle Ages* (Madison: University of Wisconsin Press, 1959); Clifford Davidson, *Technology, Guilds, and Early English Drama*, Western Michigan University Early Drama, Art, and Music Monograph Series, 23 (Kalamazoo, MI: Medieval Institute Publications, 1996); *A History of Technology and Invention: Progress Through the Ages*, 2 vols., ed. Maurice Dumas, trans. Eileen Hennessey (New York: Crown Publishers, 1969); *Medieval England as Viewed by Contemporaries*, ed. W. O. Hassall (New York: Harper and Row [Harper Torchbooks], 1965); Jacques Le Goff, *Medieval Civilization, 400-1500*, trans. Julia Barrow (London: Basil Blackwell Ltd., 1988); Edward Miller and John Hatcher, *Medieval England: Rural Society and Economic Change, 1086-1348* (London: Longman, 1978); George Ovitt, Jr., *The Restoration of Perfection: Labor and Technology in Medieval Culture* (New Brunswick, NJ: Rutgers University Press, 1986); Matthias Pfaffenbichler, *Medieval Craftsmen: Armourers* (Toronto: University of Toronto Press, 1992); Norman John Greville Pounds, *An Economic History of Medieval Europe* (London, New York: Longman, 1974); *The Didascalicon of Hugh of St. Victor: A Medieval Guide to the Arts*, trans., with introduction and notes, by Jerome Taylor (New York: Columbia University Press, 1961); Albert Payson Usher, *A History of Mechanical Inventions*, rev. ed. (Cambridge, MA: Harvard University Press, 1962); Lynn White, Jr., *Medieval Technology and Social Change* (London: Oxford University Press, 1962).

finally as a master and partner — and almost as a son. Upon Philip's death (the great wheel took his arm), Hugh, who was nineteen, married Philip's widow, who was thirty-nine, and began the manufactory's specialization in armor. He became an important member of the guild, the Armorer's Company, and by the time we catch up with him, he is recognized as the area's leading fabricator of armor.

The manufactory has expanded and now includes, in accordance with strict company rules, two journeymen and four apprentices. Hugh has added, with a dispensation from the company, half a dozen other skilled workers, under the pressure of his contract with the king for munition armor. The company has been adamant about restricting Hugh to one shop and one forge; this limitation has forced him to send out (for others to make) some parts of the armor. The king's contract has exacerbated Hugh's difficulties in securing supplies of wood, charcoal, and iron. The forest retreats before the woodcutters, and flooding in the mines renders them unworkable.

Hugh cannot approve of the expansions made necessary by large orders for munition armor. He doesn't mind someone other than himself, maybe a journeyman or even a gifted apprentice, working on rings, interlocking and riveting them into a cloth of mail. He tolerates the millman because the latter is very good at this dangerous work of polishing the finished plates — and because this was the job that killed Philip. He accepts the hammer men, because that is mere toil, not real work. But lately, Johan, a youngster with an uncanny gift for tempering, has been pestering him to make a series of anvils, each formed to a stage in the shaping of the armor, and to put a man to work on each anvil: in this way a piece of armor would be handed down a long bench from one man to the next, and would arrive fully shaped at the end, ready for tempering, polishing, and assembly.

These methods worry Hugh. A beautiful and effective (for Hugh, they are the same) harness fits like skin, and it grows like skin as Hugh shapes every part into interdependent harmony with every other. A harness of armor is part of the man who made it, and the man who made it is a part of the harness. To divide up the manufacture of it in the way Johan is proposing removes something. Hugh doesn't know what to call that something, but he feels the loss keenly. To make only one small piece of the harness — is that worker a true guildsman? Is that work part of the mystery? Or is it fit only for unskilled, interchangeable varlets repeating unskilled, interchangeable gestures?

In his conversations over a tankard of ale at the Pig and Pie with Brother Jerome, whose monastery took over Garth's mill and now has the best collection of river-driven machinery in the valley, Hugh has begun to wonder about something Jerome calls "progress." Brother Jerome has a broad mind for ideas, and thus he is not always in favor with his abbot. "There should be no limit to our desire to serve well," says Jerome, "for if we have virtue, surely it's the gift of our Blessed Lord, and to fail our gifts is to fail Him." Hugh doesn't buy this, but what can he do? How can he personally fabricate and test 1,200 harnesses in the time allowed? He can't. It's that simple. How can he refuse such an honor from the king, perhaps letting that idiot over in Camberwell get the commission? He can't. It's that simple.

Sometimes Hugh longs for the days when he worked at the forge with only an apprentice to look after the fire. He hammered the plates out of billets he carried from the nearby mine. He shaped them into pieces, each of proper thickness, annealing them to keep them malleable under his hammer. He assembled, took apart, and reassembled a harness to be sure every piece worked flawlessly with every other, closing gaps and easing frictions. He baked the parts with charcoal to turn them into steel, then tempered each to the right combination of hardness and flexibility. He polished each black and rough-edged piece, sitting at the great wheel, watching the scale shed off to reveal the gentle colors of the temper, seeing the heart of the metal shine through. Then the final assembly: filing, riveting, buffing, and fitting. Once he had made a parade armor out of gilt copper: a gorgeous living thing that fit its man like metal skin, dazzling with its elaborate engraving, red velvet picadills edged in gold, and lobster-tail *chapel de fer*.

None of that now, alas.

When he has filled this commission, perhaps he'll go back to his true craft and ignore Johan's troubling suggestions. The more he ponders, the more this munition armor worries Hugh. He makes these hundreds of harnesses, not to measure for each man, but to measurements-in-general. They'll be handed out at random, which is neither aesthetically nor ethically right. The company knows it's not right; Hugh knows it's not right. But who can resist the king?

Armor should be fitted to individual men, and it should fit. Hugh hates to think of soldiers chafing in ill-fitting breastplates and helmets, cursing him for their pain and trouble. These current methods of working don't permit the control Hugh needs to guarantee his product; the city in-

spectors can't keep up with production; and the armor goes out with only rudimentary examination, no individual testing.

What, after all, are the uses and virtues of armor? First, it must protect the wearer. Armor of proof must be tested against bolt and blow, and that cannot be done for the number units that must be finished in the time allotted. And everyone knows the variable quality of materials. Second, armor must allow the wearer to move freely on horseback and on foot. But these qualities are in tension, because the more protection armor affords, the heavier it is and the more difficult to wear. Two squires can put a knight on his feet if he's unhorsed, but Hugh has designed engines for lifting him onto his charger. That parade armor that he made out of copper moved like silk. The baron he made it for could dance in it — and he did — though his woman dented it with her fist when he stepped on her foot. One of the craft's chief mysteries consists of bringing these contrasting virtues of strength and flexibility together. In response to the commission, Hugh's armory needs to churn out munition armor so fast that Hugh doesn't feel he owns it at all. But he knows who will be blamed if a bolt pierces a cuirass or a morning star crushes a helmet.

Twelve hundred complete harnesses, at 16 shillings apiece! And more to come if these are manufactured well. Which they will be — because Hugh can't help himself there. He will make them to the best of his ability, and his best is *the* best. But what can he do with so many shillings? As Brother Jerome reminds him, God gave him the gift of his skill so that he can keep his family and support his soul, not so that he can pile up the world's goods in this vain way. The worldly reasons for working are as clear in Hugh's mind as the spiritual: work provides the necessities of life for his body, which in turn supports his soul and provides some cushion against the vagaries of climate and conditions. Work prevents idleness, the source of so many evils; it restrains concupiscence by mortifying the flesh; and it allows him to give alms to the poor, to participate vicariously in the monks' fervent contemplation, which in turn earns salvation for his entire community.

But twelve hundred harnesses — that's a lot of alms! It makes Hugh's head hurt. Brother Jerome puts into words three main questions:

- How can the Armorer's Company maintain its standards in the face of the new demand for quantity?
- To what degree must munition armor be of the same quality as a custom harness?



- At what point does a harness cease to be an expression of Hugh's calling and become instead an impersonal object, not part of God's purpose? At what point has work degraded to toil, and thus does not contribute to God's glory or Hugh's salvation?

### *The Costs and Benefits of Preindustrial Making*

About making goods for sale, Hugh had sensibilities different from ours. The preindustrial fabricator made unique things one at a time. While the form and purpose of a given product might remain constant (what started out to be a wheel ended up a wheel), this early fabricator understood that everything in that wheel, including his work, depended on everything else.

A wheelwright performed operations on materials (wood, metal, animal fat) and arranged them in a form, for a purpose. A wheel had two forms: the ideal, which was perfectly round, and the actual, which was as round as possible. Each wheel had many purposes, depending on the viewpoint of the use. A pair of wheels could carry a cart, and that was a major purpose. At the same time, making and selling them provided a living for the wheelwright. For the farmer who hauled his produce to market, wheels also provided a living.

To our modern eyes, the problem with Hugh's way of working was the cost. In Hugh's armory the costs of production were high, and he incurred them every time he made anything. Preindustrial making generated three kinds of cost: (1) the effort and resources required to arrange and rearrange equipment and materials, or the *reconfiguration* cost;<sup>18</sup> (2) the effort and resources lost when something tried didn't work, or the *exploration* cost; and (3) the effort and resources consumed in making each part of the final product, or the *variable* cost. Hugh needs to adjust his fire to account for differences in the iron content of a new batch of ore, and thus he incurs reconfiguration cost; recycling an incorrectly tempered blade that broke under testing incurs exploration cost; the work and materials used to make a helmet, independent of reconfiguration and exploration, combine as a variable cost. The sum of these three costs we call *iteration* cost.

Note that we can separate the components of iteration cost (recon-

18. Charles M. Keller and Janet Dixon Keller, *Cognition and Tool Use: The Blacksmith at Work* (Cambridge, UK: Cambridge University Press, 1996).



figuration, exploration, variable) only in our postindustrial imagination. For Hugh, they were intermingled: reconfiguration and exploration happened every time he made a helmet. Customer preferences, material properties, his own variable performance — management of variation in all of these constituted his expertise. No matter how many helmets he made, no matter how similar some might be to others, he incurred all three costs every time. Even if he made a set of similar helmets, differences in materials and the accumulation of differences in the outcomes of uncertain processes required constant process adjustments (reconfiguration and exploration). His expectations about the cost of making a helmet would remain roughly constant, no matter how many he made.<sup>19</sup>

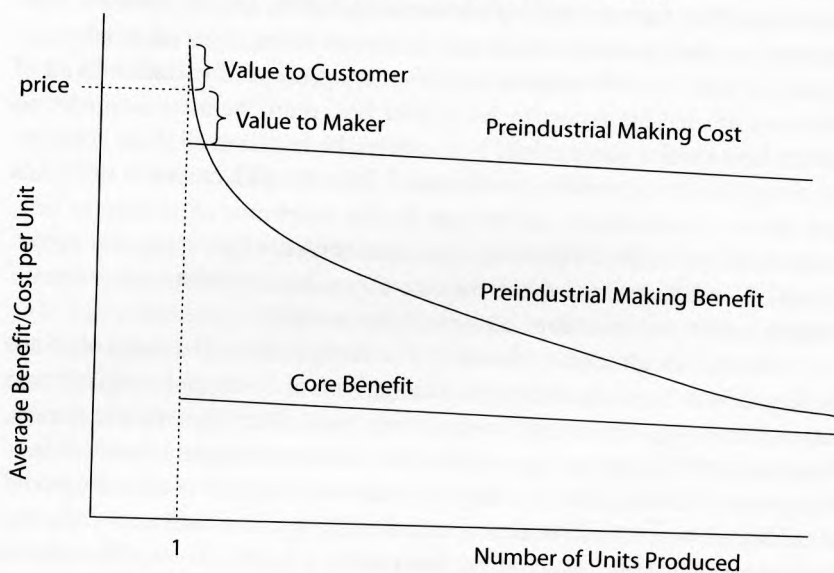
Most of Hugh's materials resisted reconfiguration. To change ore into steel, and to shape steel into parts of a harness of armor, was difficult and time-consuming. Because he worked with expensive, often rare materials, Hugh expected to incur high exploration costs every time he tried something new, which he did every time he made anything. Of course, Hugh did not think in these terms. He aimed to make a thing that would fit its purpose. He had no alternative to reconfiguration and exploration costs. Changing to fit the purpose and exploring the best ways to do that were fundamental to his mystery, the most important part of what he was doing. Because these activities had high costs, he charged a high price. Ordinary men could not afford Hugh's armor, so it was no wonder that his main customer was the king. Therefore, few transactions could occur, which created limited economic value. Replicated across the society, such limited-value creation supported a dismal standard of living. In Calvin's terms, this costly work only modestly furthered the "general advantage." But the carefully guarded secrets of the craftsman did give him leverage to keep a good part of the value for himself rather than giving most of it up to the customer or, as would become true with industrialization, to the owner of the making system.

Figure 1 illustrates the nature of transactions in Hugh's armory.<sup>20</sup> Because Hugh incurs the high costs associated with reconfiguration and exploration nearly every time he makes something, it does not matter much, in terms of average cost, how many he makes. His process is customized to

19. This assumes that the blacksmith is already a master, that he has already mastered the skills of his craft.

20. For the complete mathematical derivation of this figure, see Robert D. Austin and Lee Devin, "Determinants of Work Process Structure: Understanding Methodology Debates in Software Development," Harvard Business School working paper, July 15, 2005.

Figure 1: The benefits and costs of preindustrial making



its purpose: making requires roughly the same magnitude of expenditure each time. We see this in the nearly flat “Preindustrial Making Cost” line (no economies of scale here).

Benefit to the customer is a different story. Hugh makes everything one at a time, and they are one of a kind: or, in modern terms, he customizes his product. It provides good value to the buyer, but not as much to someone else. The benefit from Hugh’s way of working is therefore much greater for the first unit he makes than for subsequent units of the same thing. Actually, Hugh would not ordinarily think of making a second unit exactly like the first (unless that same customer ordered it). In Figure 1, we see that benefit falls off dramatically after the first unit, reflecting the fact that a second unit is not nearly as valuable to someone for whom it is not customized. The second unit of armor, made for a tall nobleman, typically won’t fit the short nobleman who walks into Hugh’s shop next. The falling benefit line approaches a level of “core benefit”: the modest protection the armor provides even if it doesn’t fit.

We also see from Figure 1 that customizing (usually) yields one transaction for one unit. The customer pays a price somewhere between benefit

and cost. Each party captures value: Hugh gets paid more than it costs him to make the armor, and the customer gets a benefit worth more than the price he paid. Even if Hugh were inclined to make another just like this one, he would have to sell it at a loss. The customized item is not valuable enough to someone other than the first buyer that it commands a price higher than the cost of making it.<sup>21</sup> It is this reality that limits the number of transactions and the potential for general advantage to the community.

### ***Toward Industrial Making***

Some version of Hugh's manufactory could have been running in England or on the continent during the seven centuries from 900 to 1600. The earlier we imagine it, the more heartfelt the connection between Hugh and his product. His idea that the harness would grow under his making, its many parts fitting each to the other, persisted throughout this time, but gradually the interdependence among the maker, materials, form, and purpose wore away. The degree of divinity Hugh would have claimed for his work would have first grown through this time, with Renaissance elaboration of the theology of work, then subsided before growing pressures to industrialize.

As the world grew commercial, the armor's purpose evolved from fulfilling the vocation of the maker (to do God's work) and a function for the buyer (to protect him) to include economic value for people in the middle who had nothing to do with the making of armor or the wearing of it. As earlier purposes became part of new commercial ones, relationships among maker, materials, and form gradually changed from interdependent to independent and preplanned. The mystery moved from the *making* itself to *figuring out how to make*. The sensibility of a maker evolved from that of Master Hugh to that of young Johan, and eventually to that of Eli Whitney, Henry Ford, and Frederick Taylor.<sup>22</sup>

21. There might be a buyer somewhere in this world to whom a second, identical unit could be sold at a profit. But limited systems of distribution made it exceedingly unlikely that the buyer could be matched with the seller so that another transaction could occur. This eventuality would not be something Hugh could count on.

22. Many others cultivated industrial thinking at more or less the same time as Whitney, Ford, and Taylor did. In Europe, musket-makers, Jacquard loom operators, and many others were working with similar ideas; in the United States, it was especially the bicycle industry. We use Whitney, Ford, and Taylor as illustrations because they are so widely known that they have

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Eli Whitney never profited much from his most memorable invention, the cotton gin. Patent disputes and outright theft tied it up in litigation for most of his life. However, he did achieve a national reputation as a maker of machines, and it was in this persona that he offered the U.S. Secretary of the Treasury a proposition that “announced the advent of America’s industrial future.”<sup>23</sup> Whitney undertook “to Manufacture ten or Fifteen Thousand Stand of Arms.”<sup>24</sup> That he had only recently seen a musket up close for the first time offered no impediment to his boldness. He chose to make muskets because only the national government had the resources he needed to implement his ideas. He asked himself what the government needed that he could make with his as-yet-untried “interchangeable system.” The government needed muskets, so Whitney chose muskets. He thought in a way our medieval Hugh could not think: about how to structure his new factory *before* he decided what to make in it.

As a child, Henry Ford just knew that he could “build a good serviceable watch for around thirty cents.” He calculated his breakeven point at two thousand watches per day. “Even then,” he said, “I wanted to make something in quantity.”<sup>25</sup> A little over thirty-five years later, he’d be thinking about Model Ts, about lowering the price to a point where his workers could buy one.

Ford’s way of organizing work became known as “mass production.” Ideas of mass production filled the air of the new century. Most elements of Ford’s Highland Park factory were already in use somewhere or other; Ford’s men borrowed and invented as they reduced the time it took to make a car. At most other automobile factories, men carried a chassis from station to station until it got wheels. Then they pushed it. Under Ford’s direction, a group of engineers and shop foremen created a *moving system* of conveyors, assembly lines that brought together parts and the accumulating chassis.

Ford’s moving lines began with a setup for building magnetos and spread throughout the factory. Engines came next, then transmissions,

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become archetypes. For a more nuanced treatment, see Michael J. Piore and Charles F. Sabel, *The Second Industrial Divide: Possibilities for Prosperity* (New York: Basic Books, 1984).

23. Jeannette Mirsky and Allan Nevins, *The World of Eli Whitney* (New York: Macmillan, 1952), p. 137.

24. Mirsky and Nevins, *Eli Whitney*, p. 138.

25. Henry Ford, *My Life and Work* (Garden City, NY: Doubleday, 1922), p. 24.

then the whole car. In August 1913, it took 12.5 man-hours to assemble a chassis. The first moving line cut that to 5 hours, 50 minutes; on December 1, 1913, the time had dropped to 2 hours, 38 minutes; and by January 1914, the time to assemble an automobile had fallen to an average of 1 hour, 33 minutes.<sup>26</sup> In less than a year Ford had reduced assembly time by a factor of eight. The number of cars produced increased amazingly: in 1911-12, Ford made 78,440 Model Ts; in 1912-13, the company made 168,304; 248,307 in 1913-14; and in 1916-17, an astonishing 730,041.<sup>27</sup>

Taylor applied the ideas of Whitney and Ford to workers. What, he asked, could a tool, a machine, and a worker accomplish in a day if they worked together at peak efficiency?<sup>28</sup> Before Taylor, the answer lay in the accumulated shop wisdom of the workers. Hugh and his fellow armorers banded together in a guild to protect their mysteries, which had evolved over centuries and had been handed down from masters to apprentices. Taylor had a mission: to pry open those mysteries, to expose them to the light of "science," and thus to make life better for everyone.<sup>29</sup>

Desiring to improve not only the owner's profits but the worker's situation, Taylor made sure that, when he set the rates and quotas for a day's work, he had based his numbers on quantities "scientifically" measured. To establish such values, he broke jobs down into their smallest gestures. Hovering at the machinist's shoulder, he timed every move over and over, suggesting improvements in arrangements and even individual gestures, until he could present his rate, method, and quota as the one best way to do the job. Taylor applied Whitney's idea of interchangeable parts to the workers: interchangeable units of labor.

Taylor and metallurgist Maunsell White also measured the speeds at which various tools cut steel. They heated some tools well beyond temperatures "known" to ruin tool steel. To everyone's astonishment, the "ruined"

26. Allan Nevins, *Ford: The Times, the Man, the Company*, with the collaboration of Frank Ernest Hill (New York: Charles Scribner and Sons, 1954), pp. 471ff.

27. Nevins, *Ford*, p. 475.

28. Sources for this section include Frederick Winslow Taylor, *The Principles of Scientific Management* (New York: Norton, 1967; first published in 1911 by Frederick W. Taylor); and Robert Kanigel, *The One Best Way: Frederick Taylor and the Enigma of Efficiency* (New York: Viking Penguin, 1997).

29. One of the chief sources of worker opposition to Taylor's methods was his insistence on scheduled rest periods. The men could not believe that he wasn't trying to slow them down so as to pay them less.

tools cut faster and wore longer than any of the traditionally tempered tools, by a factor of four or five. Taylor and White took out patents, and Bethlehem Steel mounted an exhibit at the Paris Exposition during the summer of 1900. Although its exhibition area was placed far from the center of the Exposition, the Bethlehem lathe stole the show, cutting steel at unheard-of speeds, churning out blue-hot chips that could light cigarettes.

But the long-term consequences of Taylor-White steel were not visible at the 1900 Paris Exposition. The new cutting tools rendered shop and craft mysteries, the worker's advantage, obsolete. None of the craft wisdom applied to these new steels. Taylor had a free hand to apply his systems everywhere in the shop.

Just as Whitney broke his musket down into parts, Taylor analyzed each step of a job into gestures. The same gestures could be organized for each new job, and this organizing could be done, not by the machinist according to hard-won ancient wisdom, but by a new worker, Taylor's creation, the *rate clerk*. With clean hands and a white collar, in an office far from the dirt and clamor of the shop, a rate clerk could list the gestures required for any job, sum up the time they should take, and deliver instructions to the machinist (carefully wrapped to protect them from the worker's dirty hands) telling a worker how to do the job and how much time to take at it. Control of the shop, of the manufacturing itself, passed from the machinist to the clerk. The firm could now hire workers who were less skilled, less experienced, less expensive, and less uppity.<sup>30</sup>

### *Sequential Processes Emerge*

As manufacturers improved shop methods, work took on a new shape. In order to achieve interchangeability and to create the productivity of Highland Park, the company had to specify every part of every product in advance. Taylor's rate clerks similarly prespecified every aspect of the making. Design separated from production. Industrial makers drove down unit costs and drove up the number of transactions. Workers bought

30. In the decades since his contributions to management, Taylor has often been demonized as the intellectual force behind the industrial dehumanization of work. While there is truth to this charge, there is evidence that Taylor did not intend to render work less rewarding, and it is important to realize that he worked in a different time, in different conditions, and without the benefit of our hindsight into unintended consequences.



things that formerly only the rich could afford. Henry Ford said: “[T]he question was not, ‘How much can we get for this car?’ but ‘How low can we sell it and still make a small margin on each one?’”<sup>31</sup>

The brilliance of Whitney, Ford, and Taylor lay in a crystallizing insight: if high costs of reconfiguration and exploration limit transactions, *let's stop incurring those costs*. How? Stop adjusting each thing to its unique purpose. Let the customer adjust.

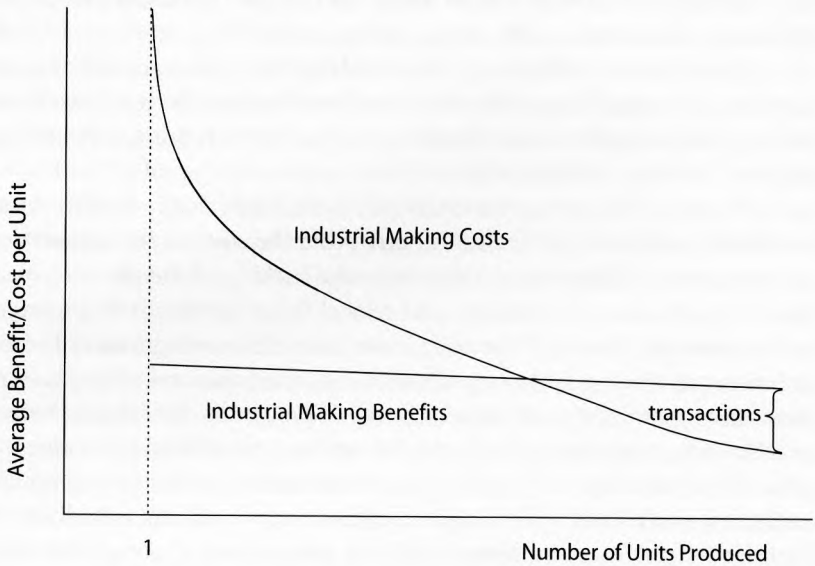
This great idea is simple and obvious in hindsight, but radically subversive in its time. Industrial methods don't avoid the costs of reconfiguration and exploration. They extract them from the making of the product, place them at the front of the process, and relabel them “product development” and “process engineering.” The costs associated with reconfiguration and exploration can then be spread equally across all manufactured units. The application of technology and improvements in process design can also reduce variable costs, often dramatically. All this makes it possible to lower the unit price. The great leap in thinking was: If we can lower the price enough, customers won't mind that the product no longer perfectly suits them. If the price is right, many customers will buy a knife that, although not fitted to them, cuts pretty well. They will trade perfect for cheap and functional.

Lower price also means many more transactions. People with one knife can afford several. This creates economic value for the seller in the form of additional profit from many more transactions (even if each transaction provides a smaller profit), and functional value for the buyer in the form of useful (not perfect) knives. Each additional transaction created additional wealth and improved living conditions. Descendents of Whitney, Ford, and Taylor continued to refine production systems, and the world benefited from more and more transactions. The great economic engine of the developed world roared to life, and the potential for increases to the common advantage expanded.

Figure 2 displays the arrangement of benefits and costs in industrial practice. The sequential structure, which spreads reconfiguration and exploration costs across many units, yields economies of scale. In Figure 2, the “Industrial Making Costs” curve dips sharply. That's a good thing, because when we make products for average users rather than customizing for individuals, they provide lower benefits. In Figure 2, the “Industrial Making Benefit” curve has become flat: users get only core benefit from a

31. *Cycle and Automobile Trade Journal*, X (Jan. 1, 1906), quoted in Nevins, *Ford*, p. 282.

Figure 2: The benefits and costs of industrial making



generic product. But when the cost curve dips far enough, we get many more transactions. Getting the cost curve to dip far enough is the purpose of Highland Park. The “transactions” region in Figure 2 is the heart of the increased standard of living in industrialized economies. It presents the potential for tremendous increase in the amount of general advantage derived from work.

But there remains the matter of how the advantage gets shared. At their worst, industrial approaches left workers with little leverage, less control, and a grim work-life that made a joke of efforts to imagine work as vocation. However, as we shall see, when we move beyond industrial work, there is hope for change in this characteristic.

### *Toward Postindustrial Making*

As “Taylorism” spread through American and European industry, it created an increasingly invidious distinction between knowing and doing, thinking and making, and between classes of workers: white-collar workers and

blue-collar workers. The new class, the white collars, made possible what Taylor called "scientific management." Taylor believed that implementing his principles improved the lot of working men and women. But that modifier, "working," tells the story. By distinguishing between "working" and something else, the division of the "blue collars" from the "white collars" dehumanized the blue collars, just as the medieval distinction between toil and work had dehumanized varlets. Scientific managers increasingly conceived of "workers" as material on which to perform money-saving, profit-increasing operations and experiments. And in thinking in this way, they lost access to the worker's skill, experience, and resourcefulness.

We cannot sustain this division between thinking and doing as we move toward postindustrial work. This new kind of work creates value from innovation, from doing things differently than they were done before. Methods that follow preset instructions do not (intentionally) deliver differences from past practice (when they do, we call that a "quality problem"). Industrial work creates its values from effectiveness in delivering *consistency*. Postindustrial work produces valuable *inconsistency*. This requires a different worker doing a different kind of work.

## Postindustrial Making

Cost reduction plays an important role in the transition to postindustrial making, just as it did in the transition from preindustrial to industrial making. But postindustrial making, which is often knowledge-based, results mainly from *reconfiguration* and *exploration* cost reduction, not *variable* cost reduction. Computing industry pioneer J. C. R. Licklider described in 1960 how technology could play a role in reducing reconfiguration and exploration cost:

Present-day computers are designed primarily to solve preformulated problems or to process data according to predetermined procedures. The course of the computation may be conditional upon results obtained during the computation, but all the alternatives must be foreseen in advance. . . . However, many problems that can be thought through in advance are very difficult to think through in advance. They would be easier to solve, and they could be solved faster, through an intuitively guided trial-and-error procedure in which the computer

cooperated, turning up flaws in the reasoning or revealing unexpected turns in the solution.<sup>32</sup>

This logic applies to making things as well as to solving problems. The great benefits of the Industrial Revolution came when “predetermined procedures” built “preformulated” products. Industrial systems could make various products, but “the alternatives [had to be] foreseen in advance.” However, innovative work, which seeks novel rather than predetermined outcomes, would be easier and would go faster if, as Licklider says, it used a “trial-and-error procedure in which the computer cooperated, turning up flaws in the reasoning or revealing unexpected turns.”

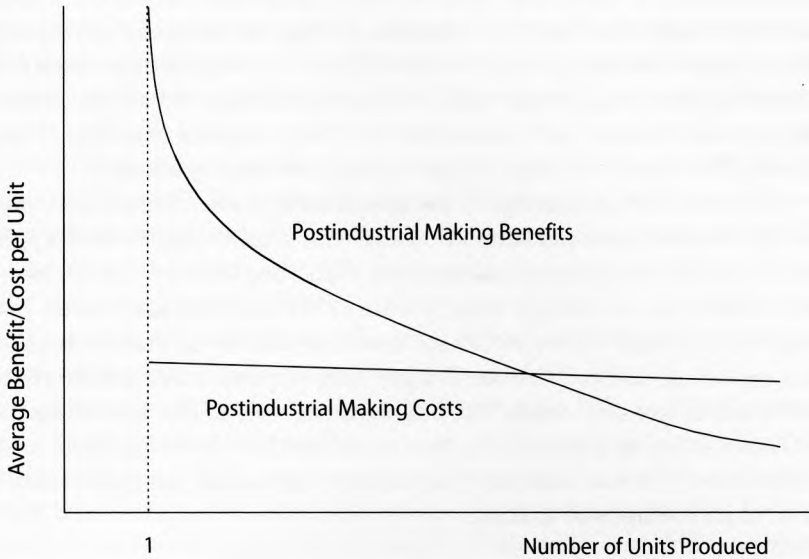
The application of technology described by Licklider makes the guided trial-and-error process cheap by reducing reconfiguration and exploration costs. As a result, new value-creation possibilities appear, along with new ways of organizing work. Knowledge work arranges and performs operations on ideas, symbols, and other “thoughtstuff”; therefore, it can have lower iteration cost than physical work to begin with, because it is easier to rearrange thoughtstuff than metal. But it is the evolution of technologies that most powerfully transforms the cost contours that shape work. Stefan Thomke has documented the many ways that technology can reduce iteration costs.<sup>33</sup> Simulation software crash-tests virtual cars far more cheaply than crashing real cars does; robotic experimentation equipment tests drug-development compounds with inhuman speed; version-control systems permit rolling back from “mistakes” in software development; and prototype-generation technologies and methods allow rapid building and testing of new ideas.

Figure 3 shows how postindustrial making, characterized by cheap and rapid iteration, enters the story of making. Cheap iteration, a feature of low reconfiguration and exploration costs, amounts to a low cost of making the first unique unit. The average cost line in this figure resembles the one in Figure 1, but is much lower. Therefore, the potential for industrialization is small. You could arrange work processes in a sequential, industrial manner, but you wouldn’t gain much. The rationale for sequential, industrial arrangement of work has weakened.

32. J. C. R. Licklider, “Man-Computer Symbiosis,” *IRE Transactions on Human Factors in Electronics*, HFE-1 (March 1960): 4-11.

33. See Stefan H. Thomke, *Experimentation Matters: Unlocking the Potential of New Technologies for Innovation* (Cambridge, MA: Harvard Business School Press, 2003).

Figure 3: The benefits and costs of postindustrial making



Because industrialization offers less potential benefit here, the work no longer needs to be directed toward the needs of an average user. We can move back toward customizing, toward making what a particular customer wants, toward the shape of preindustrial making. It is no coincidence that the shapes of benefit and cost curves in this figure are similar to the ones that described Hugh's work (even if average costs are much lower). Hugh would be happy to see that we can again craft a product to its purpose. A customer needn't put up with the knowledge work equivalent of munition armor. A software program, a strategy, a play production, even a new shirt — these can be made in endless and subtle variations. Structured *iteratively*, in cycles of doing and doing again, a making process can produce outcomes for any occasion.

Mass production developed out of the need to diffuse high reconfiguration and exploration costs across a large number of units. When those costs are not very high to begin with, or when technology can lower them, we don't need mass production. We can claim larger profit margins from individualized transactions, harvesting market niches inaccessible to a standardized product; and we can execute such transactions again and again.

We replace large numbers of cheap and rapid *repetitive* transactions with large numbers of cheap and rapid *iterative* transactions. Instead of a large number of similar units, as in industrial settings, we can make an ongoing (theoretically unending) series of units different from each other, each one benefiting from unique and value-adding innovations. We can reconceive the process outcome each time, achieving a large number of unique transactions. This way of working moves beyond industrial methods.<sup>34</sup>

Henry Ford's reductions in the time it took to assemble a chassis predate by decades computer simulation and related technologies. Both applications of technology produced startling shifts (one of which is still underway) in the way we arrange work. Architect William J. Mitchell notes that "digital technology allows architects to reduce reliance on standardization and repetition and to produce designs that respond more sensitively to varied conditions and needs." He offers the example of the Stata Center at MIT, a building of a complexity that could not have been achieved in an earlier time.<sup>35</sup> It is a creation of advantage that could not have resulted from older methods of making.

34. Creating value through customization doesn't simply mean giving every individual exactly what he or she wants or infinite proliferation of product choices for individual consumers. A growing body of research in psychology and marketing indicates that more and more choice for individual consumers doesn't mean increasing consumer satisfaction. See, for example, Barry Schwartz, *The Paradox of Choice: Why More Is Less* (New York: Ecco, 2004). The biggest source of value from customization is the ability to target products to market niches where there are relatively small (but economically significant) numbers of customers who aren't interested in standard products. Customization capability coupled with widely used low-cost distribution (e.g., via the internet), creates potential for what some have called "hyperdifferentiation." See, for example, Eric K. Clemons, Rick Spitler, Ben Gu, and Panos Markopoulos, "Broadband and Hyperdifferentiation: Creating Value by Being Really Different," in *The Broadband Explosion: Leading Thinkers of the Promise of a Truly Interactive World*, ed. Robert D. Austin and Stephen P. Bradley (Boston: Harvard Business School Press, 2005). In simple terms, from the producer's perspective, it means that you can make and profitably sell something with special features that you would not have been able to make and sell before.

It is also important to distinguish between the customization we are describing here and what has sometimes been called "mass customization." Often, mass customization systems are systems that can produce a very large number of nonetheless *prespecified* outcomes. The postindustrial processes we describe can produce outcomes that are not prespecified; this is not a capability that most mass customization systems share.

35. William J. Mitchell, "Constructing Complexity in the Digital Age," *Science* 303 (Mar. 5, 2004): 1472-74.



## The Characteristics of Postindustrial Work

We can view many late-twentieth-century advances in making practices as the result of looking simultaneously back toward preindustrial making and forward toward postindustrial making. Management gurus Peter Drucker and W. Edwards Deming, among others, realized in the 1950s and 1960s that workers themselves can best understand the complexities of evolving systems of making.<sup>36</sup> They saw that in a rapidly changing world the value of customization and innovation will increase, that making aimed at numerous niche markets can compete with mass production for mass markets,<sup>37</sup> and that technology would drive down the costs of reconfiguring plants and equipment. Increasingly, today, the game shifts from efficiency to improvement, from replication to innovation, from minimizing cost to maximizing the customer's willingness to pay. In the future, rate clerks and their modern equivalents won't be the primary source of improvement, innovation, or high-profit margins. To improve the product or service, workers themselves must take the initiative to manage and monitor systems under their control. Workers must once again become people, with individual skills and flaws, not interchangeable units of labor. Thinking about workers as people will inexorably lead management to consider how to make profitable use of all their human powers, not a mere straitened repertoire of Taylorized gestures.

The balance of power has already shifted in many settings. Consider as evidence the changed relationship between an organization's quantifiable assets and its market success. Unlike materials or equipment, the innovative competencies of people cannot be readily inventoried or listed on balance sheets; nor can the ability of employees to adapt and improvise, or the synergy of teams. One result of this is that, in some business sectors, factors that contribute substantially to a firm's market success elude financial measurement. Such "intangible assets" complicate valuation of firms and signal the return of the workplace to pre-Taylorist dependence on skill, knowledge, and lore.<sup>38</sup>

36. Peter Drucker, *The Age of Discontinuity: Guidelines to Our Changing Society* (Burlington, MA: Butterworth-Heinemann, 1968); W. Edwards Deming, *Out of the Crisis* (Boston: MIT Press, 1982).

37. This argument has recently received much attention in the popular press in discussions of "the long tail." See Chris Anderson, *The Long Tail: Why the Future of Business Is Selling Less of More* (New York: Hyperion, 2006).

38. Google, which at this writing (spring 2006) remains a dangerous mystery to its

In a knowledge economy, the unique characteristics of individual employees pose challenges for managers. Lucinda Duncalfe Holt, a software company CEO, has observed:

[Technical workers are] very difficult to control. . . . They're your most precious commodity and your worst nightmare. You have no idea what they're doing. They literally sit there with 42 little windows open on their 17-inch monitor. When [your business shifts] you'll often find the seeds for the shift in that group because they're not really paying attention to you all along anyway. They were worried about some way-out-there trend. They'll see it and there will be something there. [The key to managing] change is in that group of folks you don't have a lot of control over.<sup>39</sup>

Managers rarely know what these employees know, cannot do what they do, and have no information about work progress except what employees willingly report. The work tends to be multidimensional, idiosyncratic, and oriented toward problem-solving (even in factory settings).<sup>40</sup> To those who are not experts, it appears strange and formless; and it is difficult to observe, measure, and evaluate. Collaboration, which is common in such work, masks individual contributions. Problems of observation, measurement, and evaluation become problems of control. Ivan Sutherland, the manager of some of the researchers who created the internet, says of those workers: "You can maybe convince them that something's of interest and importance, but you cannot tell them what to do."<sup>41</sup> There is no way that the Taylorist rate clerks can run this race.

The abilities that managers cannot directly observe nevertheless manifest themselves. A highly able employee may have several useful skills, and that complicates staffing. You can't build a team by the numbers, or by reading résumés. People match up differently, and chemistry counts. "Cast

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competitors, epitomizes this aspect of the knowledge economy. The firm encourages its employees to spend up to 20 percent of their time on personal projects, and it eschews conventional strategic planning. No one knows what they'll do next, including them.

39. Robert D. Austin and Patrick D. Larkey, "Performance Based Incentives in Knowledge Work: Are Agency Models Relevant?" *International Journal of Business Performance Management* 2, nos. 1/2/3 (2000): 57.

40. The Toyota Production System provides a factory-based example of this.

41. Michael A. Hiltzik, *Dealers of Lightning: Xerox PARC and the Dawn of the Computer Age* (New York: HarperCollins, 1999), pp. 145-46.

of characters” becomes a better metaphor than does “team.” Processes designed on the industrial assumption of interchangeable units of labor function poorly when applied to those folks who are looking at 42 windows on their 17-inch screens.

Such knowledge artisans often enjoy their work. Unlike many alienated industrial workers, who work only for their paycheck, knowledge workers may see their job as an end in itself. For some — perhaps many — monetary compensation is not the primary source of gratification in work. These workers have a relationship with their work that Hugh of Llaneth would recognize and approve of.

When skilled workers are motivated and innovation is needed, questions arise about the degree to which they *should* be asked to comply with imposed structure. Plans and the systems that require people to comply with plans may keep workers doing what they are doing even when they ought to be doing something else. Holt clearly suggests exactly this: “[The key to managing] change is in that group of folks you don’t have a lot of control over. . . .” Computer industry maven Tom DeMarco,<sup>42</sup> speaking about software-development projects, makes a similar point: “The best thing you can do . . . is get on top of an absolutely out-of-control team . . . you can’t steer it, you can’t make it go faster or slower, but it is making tremendous progress.”<sup>43</sup>

Outcomes emerge in this kind of work, and managers are not the first to see the direction that the business should take. Mintzberg and McHugh have noted the importance of business activities that are not fully planned, of outcomes not fully predicted, in fast-moving organizations they call “ad-hocracies”:

Sometimes it is more important to let pattern emerge than to force an artificial consistency. . . . Sometimes an individual actor . . . creates his or her own pattern . . . ; other times, the external environment imposes a pattern . . . ; in some cases, many different actors converge around a theme, perhaps gradually, perhaps spontaneously; or sometimes senior managers fumble into strategies. . . . To manage this process is not to preconceive strategies, but to recognize their emergence and inter-

42. Among other distinctions, Tom DeMarco has received the Warnier prize for “lifetime contributions to the field of computing.”

43. Tom DeMarco, as quoted in Robert D. Austin, *Measuring and Managing Performance in Organization* (New York: Dorset House, 1996), p. 113.

vene when appropriate. . . . To manage in this context is to create the climate within which a wide variety of strategies can grow . . . to watch what does in fact come up and not be too quick to cut off the unexpected. . . .<sup>44</sup>

In this management game, value creation slips through the fingers of micro-managers: they must depend (not altogether comfortably) on workers' cooperation.

Within knowledge work, the idea of work as vocation gains new life and new potential. Even by the standards of the Greeks, work that unites the active life with the life of the mind earns some claim to divinity. With its basis in innovation, knowledge work approaches the Renaissance ideal of emulating God the craftsman. Because it shifts power back to workers, knowledge work allays at least some of the concerns of social critics about worker exploitation. Because it shifts work choices from planners to workers, knowledge work supports the ideal of work as a calling; it succeeds particularly in what Jeff Van Duzer and his colleagues at Seattle Pacific University propose as a way business can contribute to right living and a right relationship with God: by "provid[ing] opportunities for vocationally rich work through which people develop and exercise their creativity and their gifts, thus contributing to their communities."<sup>45</sup> However, it leaves each individual with a choice about the ends to which the work will be directed. Thus objectives inconsistent with Christian vocation, such as vain accumulation, remain possible.

## Caveats, Open Questions, and Conclusions

[In this job] you get a feeling you're okay, you get smarter, and that's nice, I like to be smarter. You get the satisfaction of "Ah, I understand

44. Henry Mintzberg and Alexandra McHugh, "Strategy Formation in an Adhocracy," *Administrative Science Quarterly* 30, no. 2 (June 1985): 160-97.

45. Jeff Van Duzer, Randal S. Franz, Gary L. Karns, Tim Dearborn, Denise Daniels, and Kenman L. Wong, "Toward a Statement on the Biblical Purposes of Business," in *Business as a Calling: Interdisciplinary Essays on the Meaning of Business from the Catholic Social Tradition*, ed. Michael Naughton and Stephanie Rumpza (St. Paul: University of St. Thomas, 2004). Available at <http://www.stthomas.edu/cathstudies/cst/mgmt/publications/businessasacalling.html>.

this.” You get the ah-ha feeling and you get happy, see more opportunities. I like to learn new stuff, because if I don’t — ugh.<sup>46</sup>

This [job] is a place where I’ve found a lot of hope. At a personal level, it is a place that spoke to all of me in ways that other places didn’t. There’s so much honor and regard given the soul, and the emotional life, and the life of the imagination. And it’s not pie-in-the-sky; it’s not a kind of idealist vision that has no substance or reality to it. It doesn’t feel simply indulgent and luxurious and irrelevant. It feels essential. It feels, to me, like something that brings me back and can bring other people back to what counts.<sup>47</sup>

As postindustrial work becomes more important to economic value creation, the structure of work departs from industrial models. It follows that postindustrial principles of management will differ from those of the industrial era. These principles are not fully in place yet; they will take time to invent, learn, and develop. We have barely hinted at their nature, though we have written about it at length elsewhere.<sup>48</sup> Here we’ve only briefly suggested that these new principles will result in more worker-centered value creation.

Who can do this kind of work? To make unpredictable products out of intangible materials requires education, expertise, and experience. Because of this, we face a significant risk that postindustrial societies may shake down into rigid caste systems. Imagine a knowledge economy elite supported by a large class of service jobs that do not produce much of economic value and do not support a decent standard of living for workers. It is far from self-evident that everyone will have postindustrial opportuni-

46. A graphic designer explaining why he likes his job; from interviews for the Artful Making project, Robert Austin and Lee Devin, principal investigators, 2005.

47. Quote from Nancy Shaw, a staff member at People’s Light and Theatre in Malvern, PA. As we have argued elsewhere, the way this theater runs is emblematic of the coming, and in places already arrived, world of knowledge work. Robert D. Austin, “The People’s Light and Theatre Company” (Boston: Harvard Business School Publishing, 2000), Harvard Business School case number 600-055.

48. For example, see Robert D. Austin and Lee Devin, *Artful Making: What Managers Need to Know about How Artists Work* (New Saddle River, NJ: Financial Times Prentice Hall, 2003); see also Robert D. Austin and Richard L. Nolan, “Stewards vs. Creators: Disputes and Disconnects on the Front Lines of Business Innovation,” Harvard Business School working paper, 2005.



ties and material comfort. Juan Enriquez has suggested a life-sciences-intensive scenario in which a huge portion of the world's ability to create economic value might lie within a few miles radius of MIT.<sup>49</sup> If this or something like it happens, our society may become medieval in ways that offset any divine potential within knowledge work.<sup>50</sup>

What does a society owe to people who cannot participate in its economy? As a matter of policy, we can choose to trade efficiency in an economic system for additional fairness. We do this already, often at points where economic activity intersects with morality: we outlaw prostitution or the sale of human organs, even though transactions in these areas would create economic value, strictly speaking. But we'll have to decide collectively how much of this we will do to care for less able neighbors. Such questions are hardly unique to postindustrial societies, but the transition to a knowledge-based economy prompts us to revisit them and provides new opportunities for getting answers more nearly correct. But it also poses new challenges. In our increasingly globalized world, jobs flow across national boundaries far more easily than people do. Education will be important, but our schools do not as yet prepare the next generation for knowledge work jobs. Meanwhile, emphasis on standardized courses and test scores prepares workers for the economy we're leaving, not the one we're entering. These issues present us with our latest opportunity to define ourselves before history, each other, and our gods.

The hopeful state of the work we describe should materialize, but there are reasons it might not. One possible obstacle: the market malfunction known as *monopoly*. In postindustrial work, the need to innovate transfers initiative and control from managers to workers. But by colluding to control the flow of new products to consumers, successful monopolies can reduce their need for innovation. All other things being equal, businesses will move in this direction as conditions allow. Even free markets need rules to avoid malfunctions that serve private interests at the expense of general advantage. This issue is separate from questions of trading efficiency for fairness. Markets become both unfair and inefficient without co-

49. Personal communication with Juan Enriquez.

50. We might also worry that some people do not have the innate inclination or capacity for self-directed work. This may not be entirely a matter of education, and it may generate difficulties, especially for workers with established patterns of behavior. If work has always meant just following instructions, you may have a hard time switching to self-directed work.



herent and enforceable rules about conditions of ownership, legitimate uses of market information, and allowable forms of collusive behavior.

We might also worry about the ownership claims in the knowledge economy. As we have seen, value creation depends less and less on aspects of the business that can be counted and inventoried, more and more on intangible materials and assets. The sources of economic value have never been so difficult to define. This has led companies to seek broader ownership of new sources of value. At the beginning of the twenty-first century, an intellectual property free-for-all is underway. Patents edge ever closer to assigning ownership of ideas. A major chemical company seeks to patent common pig-breeding techniques.<sup>51</sup> Other companies apply for ownership rights in the genetic material of common food crops. As long as rules remain unclear concerning which of the new sources of value can be owned, companies can't afford to let competitors gain an upper hand in the free-for-all; therefore, ownership claims will grow ever more expansive. Broad interpretations of ownership rights in the new sources of value could certainly interfere with creative work. Arrangements that slow innovation and shift power away from workers remain a lively possibility.

If we can avoid these dangers, however, future work might be something Hugh of Llaneth could understand and approve of. If he were suddenly to appear in a research lab or on a software development team in the year 2020, he would notice arrangements that look very much like the master/apprentice relationship he enjoyed with Philip. He might see daily application of mysteries unavailable to managers. He might see a level of care and interest in work reminiscent of the time he spent making that gilt copper parade harness. If we can avoid the perils of malfunctioning business and market systems, future work will be kinder than the work of the industrial past, and it will be a better fit with the Christian ideal of work as vocation.

51. See <http://www.organicconsumers.org/monsanto/pigs.cfm>.